Série N° 1:

Exercice 1:

1- $z = df = \left(\frac{\partial f}{\partial x}\right)_{yz} dx + \left(\frac{\partial f}{\partial y}\right)_{xz} dy + \left(\frac{\partial f}{\partial z}\right)_{xy} dz$

$= \underbrace{(\ln x + 1 - 2xyz)}_{A(x,y,z)} dx + \underbrace{x^2 z}_{B(x,y,z)} dy \underbrace{- x^2 y}_{C(x,y,z)} dz.$

2- $\frac{\partial A}{\partial y} = \frac{\partial B}{\partial x}$, $\frac{\partial A}{\partial z} = -2xz = \frac{\partial B}{\partial x}$

$\frac{\partial A}{\partial z} = \frac{\partial C}{\partial x}$, $\frac{\partial A}{\partial z} = -2xy = \frac{\partial C}{\partial x}$

$\frac{\partial B}{\partial x} = \frac{\partial C}{\partial y}$, $\frac{\partial B}{\partial x} = -x^2 = \frac{\partial C}{\partial y}$.

donc df est une DTE. ne dépend pas de chemain, il dépent de l'etat initiale et l'état finale. $\int_A^B df = \Delta_{AB} = f(B) - f(A)$

Exercice 2 :

1/- pour des gaz parfait :

$F(P, V, T) = 0$

$PV - RT = 0 \Rightarrow PV = RT$

$P = \frac{RT}{V}$, $V = \frac{RT}{P}$, $T = \frac{PV}{R}$

$\left(\frac{\partial P}{\partial V}\right)_T = RT\left(-\frac{1}{V^2}\right)$

$\left(\frac{\partial V}{\partial T}\right)_P = \frac{R}{P}$

$\left(\frac{\partial T}{\partial P}\right)_V = \frac{V}{R}$

$\left(\frac{\partial P}{\partial V}\right)_T \left(\frac{\partial V}{\partial T}\right)_P \left(\frac{\partial T}{\partial P}\right)_V =$

$-\frac{RT}{V^2} \cdot \frac{R}{P} \cdot \frac{V}{R} = -\frac{RT}{PV}$

$= -1.$

2/- pour des gaz réel :

$F(P, V, T) = P(V - P) - RT = 0$

$P(V - P) = RT$

$P = \frac{RT}{V - b}$, $V = b + \frac{RT}{P}$, $T = \frac{P(V-b)}{R}$

$\left(\frac{\partial P}{\partial V}\right)_T = -\frac{RT}{(V-P)^2}$

$\left(\frac{\partial V}{\partial T}\right)_P = \frac{R}{P}$

$\left(\frac{\partial T}{\partial P}\right)_V = \frac{V - b}{R}$

$\left(\frac{\partial P}{\partial V}\right)_T \cdot \left(\frac{\partial V}{\partial T}\right)_P \cdot \left(\frac{\partial T}{\partial P}\right)_V =$

$-\frac{RT}{(V-P)^2} \times \frac{R}{P} \cdot \frac{V - P}{R} = -1.$

2/- pour des gaz parfait.

$P = \frac{RT}{V}$, $V = \frac{RT}{P}$, $T = \frac{PV}{R}$

$dP = \left(\frac{\partial P}{\partial V}\right)_T dV + \left(\frac{\partial P}{\partial T}\right)_V dT$

$dV = \left(\frac{\partial V}{\partial P}\right)_T dP + \left(\frac{\partial V}{\partial T}\right)_P dT$

$dT = \left(\frac{\partial T}{\partial P}\right)_V dP + \left(\frac{\partial T}{\partial V}\right)_P dV$

$dP = -\frac{RT}{V^2} dV + \frac{R}{V} dT$

$dV = -\frac{RT}{P^2} dP + \frac{R}{P} dT$

$dT = \frac{V}{R} dP + \frac{P}{R} dV$

pour des gaz réel :

$dP = -\frac{RT}{(V-b)^2} dV + \frac{R}{(V-b)} dT$

$dV = \frac{RT}{P^2} dT + \frac{R}{P} dT$

$dT = \frac{V-b}{R} dP + \frac{R}{P} dV.$

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$\Rightarrow 32°F = a \times 0 + b$

$b = 32$

et on a : $212 = 100 \times a + b$

donc $a = 1,8$

alors : $T(°F) = 1,8\theta + 32$

- Pour le °C $\Rightarrow T(°F) = 1,8 \times 400 + 32$

$T°(F) = 752 °F$

- Pour 400°F $\Rightarrow \theta = \frac{400 - 32}{1,8}$

$\theta = 204,44°C$

2- on a $T°(F) = °\theta$

$T°(F) = 1,8°F + 32$

$T°(F)(1 - 1,8) = 32$

$T°(F) = \frac{32}{-0,8} = -40°C$

$T°F = -40°C$

$-40°F = -40°C$

3- $PV = nR(T) \rightarrow (°F)$

$PV = nRT$

$T = \theta + 273,15$

$\theta = \frac{T°(F) - 32}{1,8}$

$PV = nR\left(273,15 + \frac{T°(F) - 32}{1,8}\right)$

$= \frac{nRT°(F)}{1,8} + nR\left(273,15 - \frac{32}{1,8}\right)$

$PV = \frac{nRT°(F)}{1,7} + nR(255,37)$

Exercice 2 :

1- $\theta = an + b$

↓ graduation

Pour $n = -6 \Rightarrow -6a + b = 0$ ①

$n = 101 \Rightarrow 101a + b = 100$ ②

② - ① $\Rightarrow (101 + b)a = 100$

$a = \frac{100}{107} = 0,93$

Exercice 4 :

On détermine la fct s(T,V) sachant que : $\left(\frac{\partial s}{\partial T}\right)_V = \frac{3R}{2T}$, $\left(\frac{\partial s}{\partial V}\right)_T = \frac{1}{V}$

→ La fct s(T,V) : fonction entropie

2ème principe de thermo

c'est une fct d'état

$\int ds = \int \frac{3R}{2T} dT + \int \frac{1}{V} dV$

$S(T,V) = \frac{3R}{2} \ln(T) + \ln(V) + C$

Série 2

Exercice 1 :

$T(°F) = a \times \theta + b$

$32°F \rightarrow 0°C$

$212°F \rightarrow 100°C$

1- $400°F \rightarrow °C$??

$?? °F \rightarrow 400°C$

$\rightarrow T(°F) = a\theta + b$

$32°F = 0°C$

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et on a $\theta = 5,6$

d'où $\theta = 0,93n + 5,6$

• Pour $n = 50$

$\theta = 0,93 \times 50 + 5,6$

$\boxed{\theta = 52,1°C}$

2 - Correction $(\theta - n) = 0,93n + 5,6 - n$

$Corr = -0,07n + 5,6$

$\theta = 52 - °C \longrightarrow n = 50$

$Corr(\theta - n) = -0,07 \times 50 + 5,6$

$= 2,1$

$n = 50 \longrightarrow \theta = 52,1 \pm 2,1°C$

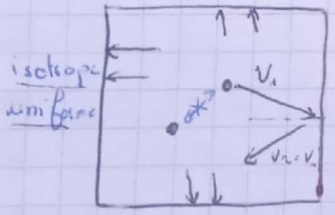
* $Corr(\theta - n) = 0 = -0,07n + 5,6$

$n = \frac{5,6}{0,07} = 80$???

pour $n = 0 \Rightarrow \theta = 5,6°C \pm 5,6$.

Exercice 3:

1 - $P = f(\eta, m, v_q)$



+ Il y a aucun chocs entre les particules

+ Il y a des chocs avec la paroi.

$P = \frac{F}{S} = \frac{\Delta(mv)}{\Delta t \cdot S} = \frac{2mv_x}{\frac{h}{v_x} \times S}$

une seule particule

avec $\Delta t = \frac{h}{v}$

Donc $P_{parti} = \frac{2mv_x^2}{V}$

$\eta = \frac{N}{V} = \frac{n \times N_a}{V}$

$P_T = P_{par} \times \left(\frac{N}{2}\right)$ uni. forme isotrope

Donc $P = \frac{2mv_x^2}{V} \times \frac{N}{2}$

$P = \eta \times m \times v_x^2$

- milieu isotrope : toute les direction sont équivalents même vitesse

$v_x^2 = v_y^2 = v_z^2$

$v_x^2 + v_y^2 + v_z^2 = \langle v^2 \rangle$

$3v_x^2 = \langle v \rangle^2$

$\langle v_x \rangle^2 = \frac{1}{3} \langle v \rangle^2$

Donc $P_T = \frac{1}{3} \eta m \langle v^2 \rangle$

2- $PV = NK_B T = \frac{1}{3} N m v_q^2$

$K_B T = \frac{1}{3} m v_q^2$

$\frac{3}{2} K_B T = \frac{1}{2} m v_q^2$

$E_c = \frac{3}{2} K_B T$

3 -

* $\eta = \frac{N}{V} = \frac{n \cdot N_a}{V}$ or $PV = nRT$

$V = \frac{nRT}{P}$

$\eta = \frac{N_a \cdot P}{RT} = \frac{N_a P}{N_a K_B T} = \frac{P}{K_B T} = 2,65 \times 10^{25}$ mol/m³

* $E_c = \frac{3}{2} K_B T = \frac{3}{2} \times 1,38 \times 10^{-23} \times 273 = 5,65 \times 10^{-21}$ J

* $v_{q\,parti} = \sqrt{\frac{2E_c}{m_p}} = \sqrt{\frac{2 \times E_c}{\frac{M}{N_A}}}$???

$v_q = 14,58 m/s$

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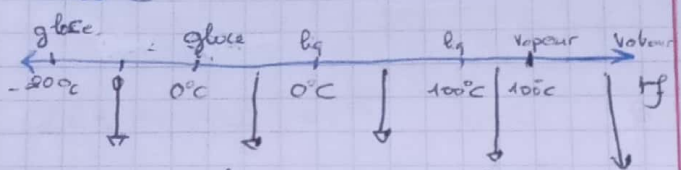
Serie 3.

Exercice 1 :

$M = 4\,kg$ glace $-20°C$ → Vapeur $t°f$??



$\Phi_{ess} = m \times L_{ess}$???

$= 0,126 \times \ldots$

$\Phi_{ess} = \Phi_1 + \Phi_2 + \Phi_3 + \Phi_4 + \Phi_5$

$\Phi_5 = \Phi_{ess} - (\Phi_1 + \Phi_2 + \Phi_3 + \Phi_4)$

$m\,C_{vap}(T_f - 100) = \ldots$

$$T_f = \frac{\Phi_{ess} - (\Phi_1 + \Phi_2 + \Phi_3 + \Phi_4)}{m\,C_{vap}} + 100$$

AN $T_f = 126°C$

Exercice 2 :

Etat (1) | $P_1 = P_0 = 1\,bar = 10^5\,Pa$; $V_1 = 3V_0$

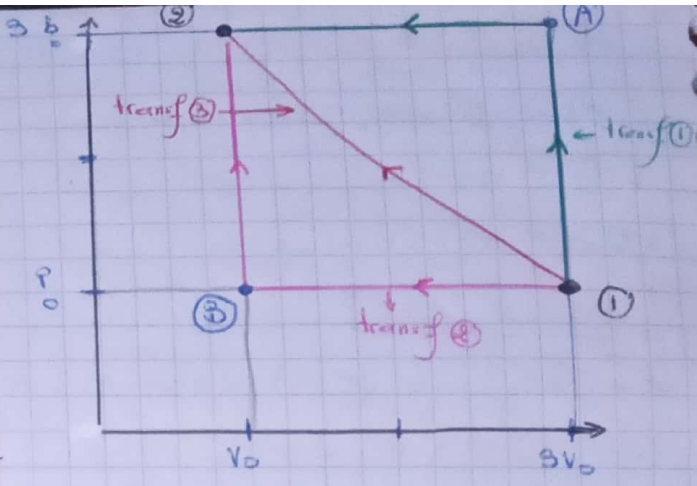
Compression PT VI

1)- transf isochore puis isobare

2)- " isobare puis isochore

3)- " isotherme → $T = cst \Rightarrow PV = cst$

Etat (2) | $P_2 = 3P_0 = 3P_1$; $V_2 = V_0 = \frac{1}{3}V_1$



2- W_1 ? W_2 ? et W_3 ?

$W_1 = W_{1A} + W_{A2}$

$= -\int_1^A P\,dV - \int_A^2 P\,dV$

$dV = de$; isochore $P = cst$

$= 0 - 3P_0(V_2 - V_1)$

$$\boxed{W_1 = 6P_0V_0 = 600\,J}$$

$W_2 = W_{1B} + W_{B2}$

$= -\int_1^B P\,dV - \int_0^2 P\,dV$

$P = cst$ isobare ⇒ $P = P_0$; isochore $V = cst$ ⇒ 0

$W_2 = -P_0\int_1^B dV = -P_0(V_0 - 3V_0)$

$$\boxed{W_2 = +2P_0V_0 = 200\,J}$$

$W_3 = -\int_1^2 P\,dV$

transf $T = cst \Rightarrow PV = cst = K \Rightarrow P = \frac{K}{V}$

$W_3 = -K\int_1^2 \frac{dV}{V} = -K\ln\frac{V_2}{V_1} = K\ln\frac{V_1}{V_2}$

$W_3 = K\ln\frac{3V_0}{V_0} = K\ln 3 = 3V_0P_0\ln 3$

$K = P_1V_1 = P_2V_2 = 3P_0V_0$

$$\boxed{W_3 = 329\,J}$$

- Le système reçu de travail

$W_1 > 0$ et $W_2 > 0$ et $W_3 > 0$

→ W travail moteur

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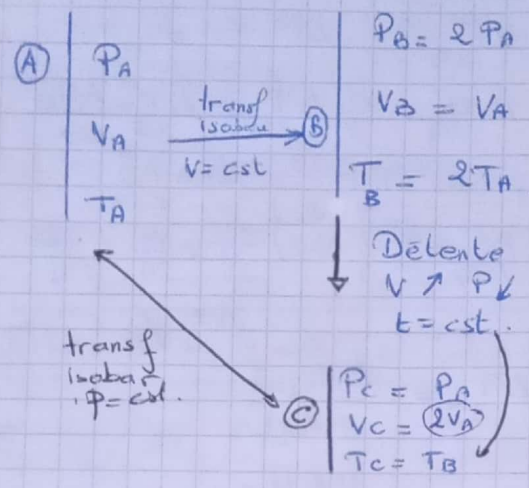
Exercice 3



1/ $V = cst \Rightarrow \frac{nRT}{P} = cst$

$\Rightarrow \frac{T_A}{P_A} = \frac{T_B}{P_B = 2P_A}$

Donc $T_B = 2T_A$.

2/ transf isotherme $PV = cst$

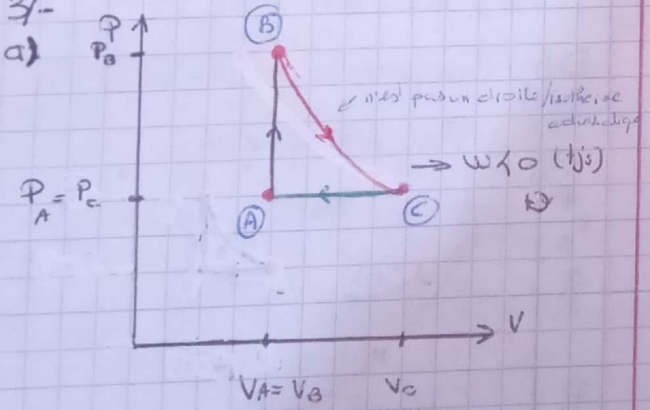
$\Rightarrow P_B V_B = P_C V_C$

$2P_A V_A = P_A V_C$

$V_C = 2V_A$

3/-

a)



b)- $W_{ABCA} = W_{AB} + W_{BC} + W_{CA}$

$W_{AB} = -\int_A^B P\,dV = 0 \quad (V = cte)$

$W_{BC} = -\int_B^C P\,dV = -nRT \int_B^C \frac{dV}{V}$

$= -K \ln\left(\frac{V_C}{V_A}\right)$

$= -K \ln\left(\frac{2V_A}{V_A}\right) = -K \ln(2)$

$= -RT \ln(2)$

$= -PV \ln(2) = -2P_A V_A \ln 2 = -2P_C V_C \ln 2$

$W_{CA} = -\int_C^A P\,dV = -P_A (V_A - V_C)$

(car P_A cst)

$= -P_A (V_A - 2V_A)$

$= P_A V_A$.

d'où $W_{ABCA} = -2P_A V_A \ln 2 + P_A V_A$

$= P_A V_A (1 - 2\ln 2)$

$W_{ABCA} = -0{,}38\, P_A V_A < 0$

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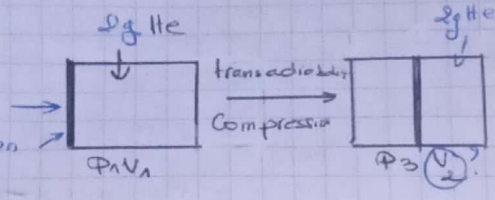
Serie N°4

Exercice 1 :



a- V_2 ?? $\quad PV^\gamma = cst$

$P_1 V_1^\gamma = P_2 V_2^\gamma \Rightarrow V_2 = V_1 \sqrt[\gamma]{\frac{P_1}{P_2}}$

AN : $V_2 = 10 \sqrt[5/3]{\frac{10^5}{3 \times 10^5}} = 10 \times \left(\frac{1}{3}\right)^{3/5}$

$\boxed{V_2 = 5,17\ l}$

b- W_{12} ??

$W_{12} = -\int_1^2 P\,dV$

$PV^\gamma = K \Rightarrow P = \frac{K}{V^\gamma}$

$W_{12} = -K \int_1^2 \frac{dV}{V^\gamma} = -K \int_1^2 V^{-\gamma}\,dV$

$= -K \left(\frac{V_2^{1-\gamma} - V_1^{1-\gamma}}{1-\gamma} \right)$

$= \frac{K V_2^{1-\gamma} - K V_1^{1-\gamma}}{1-\gamma}$

or $K = P_1 V_1^\gamma = P_2 V_2^\gamma$

$W_{12} = \frac{P_2 V_2^\gamma V_2^{1-\gamma} - P_1 V_1^\gamma V_1^{1-\gamma}}{\gamma - 1}$

$W_{12} = \frac{P_2 V_2 - P_1 V_1}{\gamma - 1}$

$\boxed{W = 826,5\ J}$

c- ΔU_{12} ?? premier principe / 1ère étape

$\Delta U_{12} = Q_{12} + W_{12}$

(transformation adiabatique)

$\boxed{\Delta U_{12} = W_{12} = 826,5\ J}$

d- ΔT_{12} ? $\quad$ 1ère loi de joule

$\Delta U_{12} = C_V \Delta T_{12} \Rightarrow \Delta T_{12} = \frac{\Delta U_{12}}{C_V}$

$\begin{cases} C_P - C_V = nR \\ C_P / C_V = \gamma \end{cases} \Rightarrow \begin{cases} C_V = \frac{nR}{\gamma - 1} \\ n = \frac{m}{M} = \frac{2}{4} \end{cases}$

$n = 1/2$

$\Delta T_{12} = \frac{\Delta U_{12} \times 2}{nR \times 3}$

$= \frac{4 \Delta U_{12}}{3R}$

$\boxed{\Delta T_{12} = 132\ K}$

Exercice 1 :

AB Compression adiabatique → A → B

$V_B < V_A$ et $P_B > P_A$

Bc : Detente isotherme ($T = T_2$) →

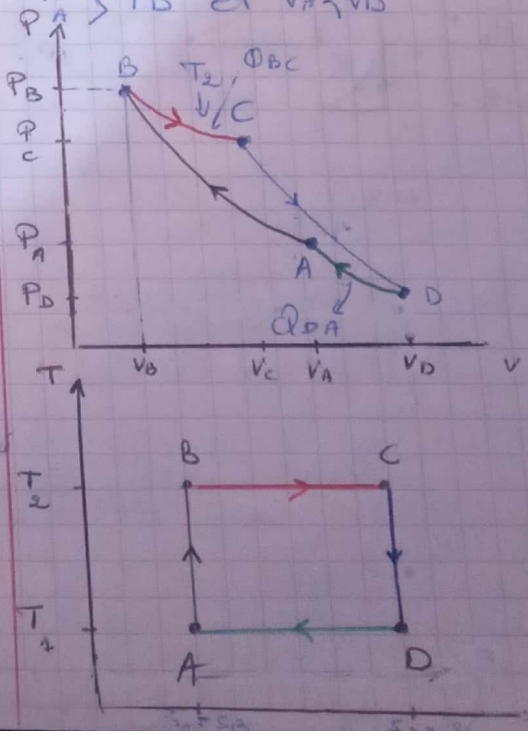
$V_C > V_B$ et $P_C < P_B$

CD : Détente adiabatique

$V_D > V_C$ et $P_D < P_C$

DA : Compression isotherme $T = T_1$

$P_A > P_D$ et $V_A < V_D$



2- Q_{AB}

Q_{BC} ?

$dS =$

ΔS_{BC}

Q_{DA}

3-

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2- $Q_{AB} = Q_{CD} = 0$, transf isantropique (adiabatique)

Q_{BC} ? Q_{DA} ?

$dS = \frac{\delta Q}{T}$ pour BC isotherme $T = T_2$

$\Delta S_{BC} = \frac{Q_{BC}}{T_2} \Rightarrow \boxed{Q_{BC} = T_2 (S_C - S_B) > 0}$

$\boxed{Q_{DA} = T_1 (S_A - S_B) = -T_1 (S_C - S_B)} < 0$

3- W_T ?? 1ère principe de thermo / 2ème énonce

$\sum W + \sum Q = 0$ (cycle reversible)

$W_T + \underbrace{Q_{AB}}_{0} + Q_{BC} + \underbrace{Q_{CD}}_{0} + Q_{DA} = 0$

$W_T + Q_{BC} + Q_{DA} = 0$

$W_T = -(Q_{BC} + Q_{DA})$

$\Rightarrow W_T = (S_C - S_B)(T_1 - T_2)$

$S_C > S_B \quad T_2 > T_1$

$\Rightarrow W_T < 0$

c'est un normalement cycle de carnot, but c'est de produire la chaleur → le sens du cycle se fait ds le sens horaire.

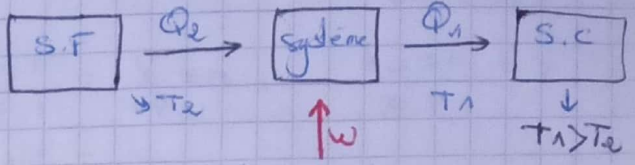
3- $\eta = \frac{|W|}{Q_{BC}} = \frac{|(S_C - S_B)(T_1 - T_2)|}{(S_C - S_B) \times T_2}$

$= \frac{T_2 - T_1}{T_2}$

$= 1 - \frac{T_1}{T_2} > 0 < 1$

$\eta = 1 - \frac{T_{source\ froide}}{T_{source\ chaude}}$

Exercice 3 :



$W > 0$, $Q_1 < 0$, $Q_2 > 0$

1/- $\sum W + \sum Q = 0$ 1ère principe / 2ème énonce

$W_T + Q_1 + Q_2 = 0 \Rightarrow W_T = -(Q_1 + Q_2)$

$W > 0$; $Q_1 < 0$ (cédé) ; $Q_2 > 0$ (reçu)

$|Q_1| > |Q_2|$

2/- $W_T = -Q_1 - Q_2$

$W_T + Q_1 + Q_2 = 0$

D'après l'égalité de carnot :

$\frac{Q_1}{T_1} + \frac{Q_2}{T_2} = 0$

$\Rightarrow Q_1 = -T_1 \frac{Q_2}{T_2}$

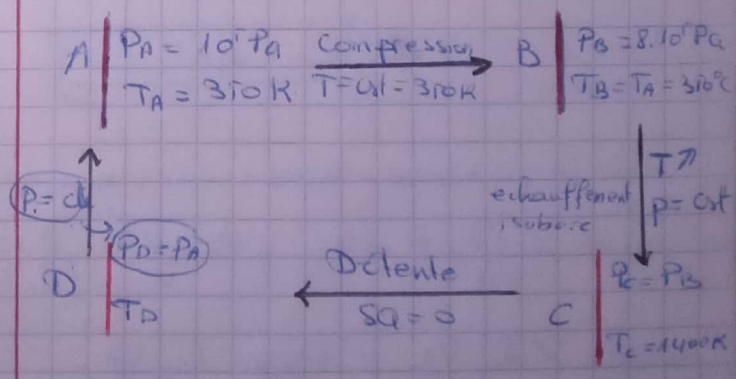
$W_T - \frac{T_1}{T_2} Q_2 + Q_2 = 0$

$W_T - Q_2 \left(\frac{T_1}{T_2} - 1\right) = 0$

$\Rightarrow Q_2 = \frac{T_2 W_T}{\underbrace{T_1 - T_2}_{T_1 > T_2}} > 0 \Rightarrow Q_2 : Reç$

3- $e = \frac{Q_2}{W_T} = \frac{T_2}{T_1 - T_2} > 1$

Exercice 4 :



1/- C_p

$\begin{cases} C_p - C_v = nR \\ C_p / C_v = \gamma \end{cases} \Rightarrow C_p = \frac{nR\gamma}{\gamma - 1}$

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1,3 g → 1 l

1000 → V

$V = \frac{1000}{1,3}$, $n = \frac{V}{V_M} = \frac{1000}{1,3 \times 22,4} = 34,5 \text{ mol}$

2 $\boxed{C_p = 1003,4 \text{ J/K}}$

2- V_A, V_B, V_C, V_D, T_D

gaz parfait ⇒ $V_A = \frac{nRT_A}{P_A} = 1 m^3$

$V_B = \frac{nRT_A}{P_B} = 0,125 m^3$

$V_C = \frac{nRT_C}{P_C} = 0,5 m^3$

V_D : Loi de Laplace CD, transf adiabatique

$P_C V_C^\gamma = P_D V_D^\gamma$

$V_D = V_C \left(\frac{P_C}{P_D}\right)^{1/\gamma}$

$\boxed{V_D = 2,2 m^3}$

T_D : gaz parfait $T_D = \frac{P_D V_D}{nR}$

T_D Loi de Laplace $TV^{\gamma-1} = cst$

$T_D V_D^{\gamma-1} = T_C V_C^{\gamma-1}$

$\boxed{T_D = 773 K}$

3/- $\eta = \frac{|W|_{ABCDA}}{Q_{BC}}$ (travail donné / chaleur donnée), $Q_{BC} = C_p \Delta T$

$= C_p (T_C - T_B)$ (la chaleur donné au système 350 → 1400)

$= C_p (1400 - 350)$

transf isobar ← $\boxed{Q_{BC} = 1,05 \cdot 10^6 J}$

$W_T = W_{ABCDA} = W_{AB} + W_{BC} + W_{CD} + W_{DA}$

$W_{AB} = \int_A^B -P \, dV$, $P = \frac{nRT}{V}$, $PV = cst$ (isotherme)

$W_{AB} = K \ln \frac{V_A}{V_B} = P_A V_A \ln \frac{V_A}{V_B}$

$\boxed{W_{AB} = 2,08 \cdot 10^5 J}$

$W_{BC} = -P_B (V_C - V_B) = -3 \cdot 10^5 J$

$W_{CD} = \frac{P_D V_D - P_C V_C}{\gamma - 1}$

$\boxed{W_{CD} = -4,48 \cdot 10^5 J}$

$W_{DA} = -P_A (V_A - V_D)$

$W_{DA} = 1,208 \times 10^5 J$

Donc :

$\boxed{W_T = -419 kJ}$

$\eta_{ABCDA} = \frac{14 \times 91}{1050} = 0,4\%$

$\eta_{carnot} = 1 - \frac{350}{1400}$

$\eta_{carnot} = 0,75\%$

(aucun cycle ne peut atteindre le rendement de Carnot)

4/-

	W	Q	ΔU
AB	$2,08 \cdot 10^5$	$-2,08 \cdot 10^5$	0
BC	$-3 \cdot 10^5$	$10,5 \cdot 10^5$	$7,5 \times 10^5$
CD	$-4,4 \times 10^5$	0	$-4,4 \times 10^5$
DA	$1,20 \cdot 10^5$	$-4,28 \cdot 10^5$	$-3,08 \times 10^5$
	$1,208 \cdot 10^5$		
total DA	$-4,19 \times 10^5$	$4,19 \cdot 10^5$	0

SHOT ON OPPO

Scanné avec CamScanner